

Children with Down syndrome learning mathematics:

Can they do it?

yes they can!



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GERVASONI discuss
some teaching
approaches that can be
used to assist children
with Down syndrome
to learn mathematics.



Background

The mathematical development of children with Down syndrome (DS) is largely uncharted territory and yet the experience of parents and teachers reminds us that children with DS can and do learn mathematics. In the 1970s, few children with DS had access to schooling and authorities in the field (Restak, 1975, cited in Rynders & Horrobin, 1990) were still arguing whether education was possible! Three decades later, the specific area of mathematics education for DS children remains an emerging field. In 2008, many children with DS in Australia attend their local school and are included in classrooms with their age peers. At present, little research information is available to guide teachers to provide the best opportunities for the children to learn mathematics. Some suggestions are provided in the resource list at the end of this article.

Down syndrome is one of the most common congenital chromosomal variations present in all populations, occurring approximately once in 700 Australian births (Selikowitz, 1997). Down syndrome results almost universally in intellectual impairment, although the extent of the disability varies. People with Down syndrome have been part of many research studies and a great deal is known about how they learn (Buckley & Bird, 2002; Wishart, 2002), their physical

development (Bruni, 2006; Winders, 1997) and their acquisition of language (Buckley, 2000). However, very little is known about their acquisition of mathematical concepts.

Against this background of limited DS research, there is a stark contrast with the burgeoning interest in the mathematical development of children in general early childhood settings in Australia. A number of Australian states have undertaken major projects to assess and provide early intervention in mathematics (some states focussing on Number) such as the Early Numeracy Project (Victoria), Count Me In Too (New South Wales), Year 2 Net (Queensland) and First Steps (Western Australia). Through these projects, a considerable amount of data on the mathematical development of Australian children has been obtained (Bobis et al., 2005).

A brief description of the study

The research project used task-based interviews to gather data on the mathematical development of children with Down syndrome, modifying the Early Numeracy Interview (Clarke et al., 2002) and the Early Mathematics Understandings instrument (Gervasoni, 2004). Although these instruments are already demonstrably effective, modification, trial and development was necessary because, to our knowledge, neither had been used with children with Down syndrome.

Twelve children, ranging in age from 6 to 12 years, were recruited for participation in this study. The children were interviewed twice in the year, around July and November. The interview involved asking children to perform tasks with objects. For example, we put a collection of plastic teddy counters on the table and asked the participant to put all the yellow teddies together and then to count them. The equipment was put in a variety of interesting boxes and containers to encourage curiosity about the tasks.

We videotaped the interviews and parents were invited to observe and make notes for discussion later. Figure 1 shows an interview in progress



Figure 1

Interviewing the children

In making decisions about the staging of the interviews, we were mindful of research that demonstrated the diminished performance of children when they were interviewed in clinical settings by researchers they did not know (Brown & Semple, 1970). Therefore, children were interviewed in a familiar setting in the presence of a parent. On one occasion, a teacher observed as well and, in another, a teacher aide was present.

Time was spent at the start of the interview chatting to the parent and the child. This allowed the interviewer the opportunity to become accustomed to the style of communication of the child. Some of the children appeared nervous at the start, although most were clearly excited.

We were astonished at the variety of approaches the children took in the interview. The behaviour of the children ranged from confident performance (even described by one mother as 'showing off') to shy whispering. One of our younger participants found it all too much and needed considerable encouragement from his mother to continue the interview. The most surprising was one of our older students. At the start of the interview, 'Mr T' was very reluctant to participate. He refused to answer any questions, though was engaging when the interviewer was chatting

and asking about non-mathematics topics. As soon as task questions were posed, he folded his arms and looked away. For some time, particularly with the early counting tasks, he gave the impression he was unable to count. Due to his maturity in conversation (and his mother rolling her eyes and shaking her head in the background!) the researcher was fairly certain this was not the case. The interviewer used techniques such as pretending to make mistakes with counting to observe if he noticed. He did, and so it was obvious he was able to perform the task — he just did not want to show that he could. Similar behaviour has been observed by Wishart (1996). Having carers present who could tell us if their child was under-performing as well as providing opportunities in the interview to approach a concept from alternative tasks were strategies we have deliberately employed to enhance the likelihood of our gaining data we could trust. For many of the children, the interviewer made use of a sticker chart to encourage and reward participation. Interviews lasted between 30 and 60 minutes and most of the children were engaged through that time. The stickers assisted to maintain interest. In two interviews, notably Mr T's, the stickers served as a supplementary counting task. Mr T had to earn 15 stickers before he could leave. Suddenly, we found out he could easily count, could self-correct with reference to the hundreds chart and could perform mental calculations such as how many more stickers he needed!

Suggestions for teachers

In this section, we offer suggestions arising from the initial analysis of our research data and from our experience of teaching children with Down syndrome. We have completed the interviews and commenced the analysis of the data. It is exciting to see the study unfolding. There is an enormous amount of data resulting from the video

taped interviews and conversations with parents to be analysed. The small sample allows us to study individual cases in detail. It is early days in the analysis of our data but we believe our suggestions may be helpful and further investigation will follow.

Taking a visual approach to number concept development

Young children with Down syndrome will come to school varying greatly in their language development. Many children will be using signing to support their developing spoken language. Even so, many already will be reading! Using methods proposed by authors such as Oelwein (1995), children are taught to read using sight words and for many this has been observed as a first language, with speaking coming second and enhanced as a result. We believe this well researched approach to teaching reading (Buckley, 2000) can underlie an alternative approach to teaching counting.

Usually young children learn the oral count words first and many typically developing children arrive at school being able to say long strings in the counting word sequence. For children with DS, this may not have occurred due to difficulties with oral language. Our research suggests this does not mean they are unable to count. It may be that some of the children who are as yet unable to say the count word sequence are able to order numbers and so would appear to have some aspects of the number concepts.

Matching involves matching a numeral written on a card to an identical numeral on another card. Begin with one numeral to match — small steps allow the learner to succeed at each stage and practise before moving on. As one numeral is learned move to others. The order is not important at this stage. Selecting is more difficult. Given some numerals, the child selects the target numeral when the teacher asks for it. Finally, naming is the stage where the child names (or signs) the numeral when shown the card.

Learners with DS are likely to have a relative strength in the visual learning mode. This can be used to support the development of the oral and symbolic aspects of number concept development: emphasise the visual by teaching the symbols (numerals) and the connection to the word. Oelwein (1995) advocates the approach of 'match, select and name' sequence.

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Once the numerals are known, the order can be taught. Counting songs are excellent for this, but the tempo needs to be slow to allow time for signing or processing the words. Videos showing Makaton signing to children's songs are available (see resource list) and give a good guide to how slow the tunes should be.

Focussing on visual approaches to learning number concepts has received recent attention (Bobis, 2008). Bobis has argued for the importance of part-whole knowledge and subitising (the process of being able to determine how many items there are without counting them), these being developed through a range of visual approaches. Some of the children in the study were successfully using materials such as real objects and number lines to perform calculations, hundreds charts to support counting and bundling sticks to understand place value concepts.

Approaches such as the use of ten-frames, five-frames, number lines, empty number lines and hundreds charts are commonplace in Australian primary classrooms. These manipulative materials and visual strategies assist learners to develop number sense using spatial methods. Numicon, developed in the UK by Wing and Tacon, is a multi-sensory mathematics teaching program using plastic shapes for 1 to 10 in set arrangements. It has been promoted as a successful approach

for children with Down syndrome (Wing & Tacon, 2007). The materials focus on subitising, learning number combinations and calculating without relying on counting. Similar materials, more common in Australian classrooms, that focus on spatial thinking may well be as effective.

In focussing on developing number concepts, we are aiming for the development of number sense. Having a sense of what the number 'three' actually is involves gaining an understanding of the concept in several forms: as a symbol, as language, as representations in various arrangements of materials, as connected to other numbers. Finally, links between the forms of the concept are required for deep understanding of 'three-ness.' In teaching number to develop this rich concept, we need to use a variety of approaches. It is our view that children with Down syndrome will access the development of number sense more readily by focusing on visual and kinaesthetic approaches, with language and oral methods introduced alongside.

Feedback to parents

Parents were an integral part of our research study. They watched the interviews and gave us advice about their child's participation, the wording of questions and background information about schooling. In addition to the information the parents provided to us, we were conscious of how desperate the parents were for information from us. Parents clearly wanted to know about the mathematical development of their child. It can be very difficult for a parent of a child with an intellectual impairment to gain a realistic view of performance, perhaps particularly if the child is attending a local school. Comparison with typically developing peers is unhelpful and yet other measures are not readily available as an alternative. Children with learning disabilities are commonly withdrawn from state and now national testing, and comparisons with age

peers are unhelpful if the child with DS is working on an adjusted program. Few have access to comparisons with others with DS.

At the end of the interview, many parents expressed keen interest in our opinion of how their child had performed. This research may begin to provide ways to help parents and teachers to judge the educational progress of the child with Down syndrome.

We would recommend an approach where teachers report specific achievements against the 'big ideas' of mathematics, such as those specified in syllabus documents. Accomplished concepts as well as emerging concepts are helpful for parents to know. Providing information about where the child is headed would also be important. Parents attend planning meetings for their children and it is helpful for them to have detailed information to support their contribution. Teachers may also be surprised at the extent to which parents of children with Down syndrome read research. All the parents in our study were keenly aware of the literature on Down syndrome. Clearly, there is likely to be a sampling effect here — parents with an interest in research are more likely to participate in studies — however, even so, parents are often part of support groups and can be very knowledgeable. Teachers can use this knowledge as a resource; invite parents to share latest research or information and follow up with them after you have had time to read and consider the information.

Deciding what to teach

In the development of individual learning programs for children with Down syndrome, decisions need to be made about what to teach. In the early years, the programs will be similar to those for other children in the class, ensuring an emphasis on visual learning approaches. As the child moves through primary school, the gap between their mathematical development and that of their age peers tends to widen. Decisions then need to be made about what to teach.

In our study, the older children who were included with age peers were learning a range of mathematics from across the discipline. They were using similar approaches and manipulative materials to others in their class and the effectiveness of this could be seen in their performance during the interview. These children were successful at a range of tasks and were familiar with the standard classroom materials, such as hundreds charts and calculators (see Figure 2).

From the initial analysis of our data, it would seem that assisting children to work on similar content to that of others in the class is an effective approach. Strategies for diversifying the curriculum are available elsewhere (see for example, Browder & Spooner, 2006; Carnellor, 2004).

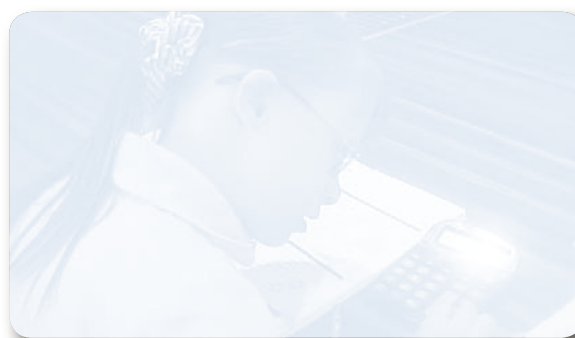


Figure 2

Future plans

Our main purpose in this research is to empower teachers and parents through the understanding we hope to gain about the mathematical development of children with Down syndrome. Only through research can those closely involved in the teaching and learning process be advised of best practice approaches. In the 1960s, life expectancy for people with Down syndrome was around 15 years. Now, it is more than 50, with one in ten living to their seventies (Brown, 1996). Preparation for a long adulthood is essential and begins in the early years. Foundation concepts of mathematics underpin lifelong numeracy development, an important goal for all learners, including those with Down syndrome.

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References

- Bird, G. & Buckley, S. (2001). *Number skills for individuals with Down syndrome — An overview*. Hampshire: The Down Syndrome Educational Trust.
- Bobis, J. (2008). Early spatial thinking and the development of number sense. *Australian Primary Mathematics Classroom*, 13(3), 4–9.
- Bobis, J., Clarke, B. A., Clarke, D., Thomas, G., Wright, R. & Young-Loveridge, J. (2005). Supporting teachers in the development of young children's mathematical thinking: Three large scale cases. *Mathematics Education Research Journal*, 16(3), 27–57.
- Browder, D. M. & Spooner, F. (Eds) (2006). *Teaching Language Arts, Math, and Science to Students with Significant Cognitive Disabilities*. Baltimore, MA: Brookes.
- Brown, R. I. (1996). Growing older: challenges and opportunities. In B. Stratford & P. Gunn (Eds), *New Approaches to Down Syndrome* (pp. 436–450). London UK: Cassell.
- Brown, R. I. & Semple, L. (1970). Effects of unfamiliarity on the overt verbalisation and perceptual motor behaviour of nursery school children. *British Journal of Educational Psychology*, 40(3), 291–298.
- Bruni, M. (2006). *Fine Motor Skills for Children with Down Syndrome: A Guide for Parents and Professionals* (2nd ed.). Bethesda, MD: Woodbine House.
- Buckley, S. (2000). *Speech and language development for individuals with Down syndrome — An overview*. Southsea, UK: Down Syndrome Educational Trust.
- Buckley, S. & Bird, G. (2002). Cognitive development and education: Perspectives on Down syndrome from a twenty-year research programme. In M. Cuskelly, A. Jobling & S. Buckley (Eds), *Down syndrome across the life span*. (pp. 66–80). London: Whurr.
- Carnellor, Y. (2004). *Encouraging mathematical success for children with learning difficulties*. Southbank, Victoria: Social Science Press Australia.
- Clarke, D. M., Cheeseman, J., Gervasoni, A., Gronn, D., Horne, M., McDonough, A., Montgomery, P., Roche, A., Sullivan, P., Clarke, B. A. & Rowley, G. (2002). *Early Numeracy Research Project Final Report*. Melbourne, Australia: Mathematics Teaching and Learning Centre, Australian Catholic University.
- Gervasoni, A. (2004). *Exploring an intervention strategy for six and seven year old children who are vulnerable in learning school mathematics*. Unpublished Doctoral thesis, La Trobe University, Bundoora.
- Oelwein, P. L. (1995). *Teaching reading to children with Down syndrome: A guide for parents and teachers*. Bethesda: Woodbine House.
- Rynders, J. & Horrobin, J. (1990). Always trainable? Never educable? Updating educational expectations concerning children with Down's syndrome. *American Journal on Mental Retardation*, 95, 77–83.
- Selikowitz, M. (1997). *Down Syndrome: The Facts*. (2nd ed.). London: Oxford University Press.
- Winders, P. (1997). *Gross Motor Skills in Children with Down Syndrome: A Guide for Parents and Professionals*. Bethesda, MD: Woodbine House.
- Wing, T. & Tacon, R. (2007). Teaching number skills and concepts with Numicon materials. *Down Syndrome Research and Practice*, 12(1), 22–26.
- Wishart, J. G. (1996). Avoidant learning styles and cognitive development in young children. In B. Stratford & P. Gunn (Eds), *New approaches to Down syndrome*. (pp. 173–205). London, UK: Cassell.
- Wishart, J. G. (2002). Learning in young children with Down syndrome: public perceptions, empirical evidence. In M. Cuskelly, A. Jobling & S. Buckley (Eds), *Down Syndrome Across the Lifespan* (pp. 18–27). London: Whurr.

Resource list

Resource kit

DSAQ. (2000). *Where do we go from here? Information and ideas for regular primary schools about including a child with Down syndrome*. Brisbane: Down Syndrome Association of Queensland.
[Contact www.dsaq.org.au]

Practical Teaching Strategies in Numeracy series of 5 books

Munro, J. (2000). *Practical Teaching Strategies in Numeracy*. Northcote, Victoria: Down Syndrome Association of Victoria.
[Available through MAV: www.mav.vic.edu.au]

Makaton signing video

Variety Clubs of Australia
[Available <http://www.varietytas.org.au/index.php?id=783>]

Down Syndrome Issues and Information Series

DownsEd: Porstmouth UK: Down Syndrome Educational Trust
2001 - Series editor Professor Sue Buckley.
Number skills for individuals with Down syndrome: an overview
Number skills development for infants with Down syndrome (0–5 years)
Number skills development for children with Down syndrome (5–11 years)
Number skills development for teenagers with Down syndrome (11–16 years)
[Available <http://www.downsed.org/information/>]

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